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A Program and Project Management Approach for Collaborative University-Industry R&D Funded Contracts

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Abstract

This paper presents a new program and project management (PPM) approach especially devoted to support collaborative university-industry R&D funded contracts. While the literature provides some advice on how to embark on designing such PPM approach, university-industry collaboration contexts require specific guidance. The research described in this paper aims to make some contribution to theory as well as to practice by discussing the PPM approach adoption in a case study collaborative university-industry R&D funded contract between the University of Minho and Bosch Car Multimedia Portugal S.A., named – HMIExcel. The results show that emphasis should be given to structured objective setting, good progress monitoring and effective communication. The research study is ongoing through the use of a questionnaire and focus groups, in order to improve the presented PPM approach conceptualization.

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Keywords: Program and project management; University-industry collaboration, R&D funded contracts.

1. Introduction

Given the Grand Challenges of the 21st Century, university-industry partnerships are expected to play an important

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role through the development of new products, technologies and processes for industry[31]. Research collaboration has become the norm in every field of scientific and technical research[7]. The major incentives to industry collaborate with a university is the access to research and critical competencies, which allows firms to reach the very edge of contemporary technology[14], and the major incentives for researchers' academy is the access to equipment and additional research resources[35]. The collaboration between academia and industry is encouraged by governments as a means of enhancing national competitiveness and wealth creation[5]. With the increasing prevalence of university-industry partnerships and their importance to the future success of both organizations and to national economies, it is essential to develop new methodologies and new innovative approaches to address the collaborations challenges. Namely, methodologies to manage university-industry research projects and programs, which are important vehicles to operationalize university-industry partnerships[10].

Literature research concerning university-industry collaboration has concentrated primarily on the existence and effects of the so-called "cultural gap"[4]. The factors identified include conflicts over ownership of intellectual property, academic freedom to publish, differences of priorities, and time horizons. However, Barnes, Pashby and Gibbons[4] suggest that the majority of the problems associated with the "cultural gap" can be alleviated by good project management (PM).

PM has been shown to deliver tangible and intangible benefits to organizations[22, 37]. However, PM remains a highly problematical endeavor. Projects still fail to live up to the stakeholders' expectations as they continue being disappointed by projects' results[23], namely in university-industry research projects[10]. Commonly cited reasons include the different motivations and objectives of the organizations involved[8, 31], variable level of commitment[15], failure to establish trust[13], unclear requirements[5], and poor planning and progress monitoring[10]. These factors have also been widely recognized as affecting negatively conventional projects[10].

Other important issue is that PM is highly contingent on the organizational context, such as structure of business or industry sector, size, and its environment[6]. Cooke-Davies, Crawford and Lechler[12] argue that the value of PM is a function of what is implemented and how well it fits the organizational context, and as expected, projects in collaboration between two distinct organizations (university and industry) with different cultures and mindsets and funded for an external body, have several specificities that require attention during the development of the approach to manage those joint initiatives. Barnes, Pashby and Gibbons[5] argue that particular emphasis should be given to structured objective setting, good progress monitoring, effective communication and high quality project managers to run the collaboration.

While the literature provides some advice on how to embark on designing such program and project management (PPM) approach[4, 10], the specific context of university-industry collaboration demands a strong research effort to produce effective guidelines.

This paper aims to make some contribution to theory as well as to practice by discussing a new (PPM) approach specifically devoted to support collaborative university-industry R&D funded contracts. The development of the PPM approach was based on a review of the literature and on the analysis of the context of a HMIExcel (Human Machine Interface Excellence) case study that resulted from a funding contract between the University of Minho (UMinho) and Bosch Car Multimedia Portugal S.A. (Bosch_BrgP).

Although HMIExcel for the funding body is seen as a project, its complexity and uncertainty led the consortium (UMinho and Bosch_BrgP) to manage it as a program. A program is a set of projects that are somehow related and contribute to the same goal[29], in the case of HMIExcel, for the development and production of advanced multimedia solutions for automobile. Fundamental differences are found in the way projects and programs are managed, namely in response to uncertainty and change[17].

The paper follows a common structure. The second section discusses the concepts of project and program management, and the main theoretical foundation for the PPM approach proposed and used in the case study HMIExcel program. The third section describes the research methodology applied in this study. The fourth section specifies the program case study HMIExcel context. The fifth section briefly presents the new PPM approach conceptualization. Finally, the main findings that emerged from this study, as well as, the suggestions for future work are discussed.

2. Literature Review

In practice, the concept of project has been broadened from an initial focus on management of largely unitary, standalone projects with well-defined and agreed goals and end products, to include multiple projects and programs that are multidisciplinary, and which are not pre-defined but permeable, contested and open to renegotiation throughout[3].

In this paper, a traditional view was adopted, defining a project as a temporary endeavor in which human, material and financial resources are organized in a novel way to create a unique product, service or result[16]. A project is comprised by a set of defined deliverables, the scope to fulfil the project objectives, constrained by time, cost and predetermined performance specifications[9]. PM is seen as a disciplined method of achieving well-defined goals through deployment of tried-and-tested tools and techniques for planning, organizing, control and evaluation of work[16].

There are many definitions of program management, and this plurality and diversity can be associated with their origins and lack of common understanding[33]. Most definitions come from organizations that are heavily into PM like Project Management Institute, Association for Project Management or Office of Government Commerce. All these definitions have common and different elements. The main common points are (i) programs usually cover a group of related projects; (ii) their management must be coordinated, and (iii) must create a synergy, which will generate greater benefits than projects could do individually[11, 17, 19, 21, 27, 36]. The main differences are of two kinds - some program definitions, beyond related projects also cover linked ongoing operations; other program definitions just cover related projects, such as the definitions of the Project Management Association of Japan[19] and Project Management Institute[17]. Thiry[36] (p 221) tries to integrate the definitions and defined program as *"...a collection of change actions (projects and operational activities) purposefully grouped together to realise strategic and/or tactical benefits"*. The concept of purposefulness is related to the objectives, which need to be defined. The word 'actions', refers to on-going projects, as well as operations. The benefits can be either strategic or tactical, but are always measured at organizational level and the benefits and objectives may change overtime[11].

The definition of projects is generally outside the program's sphere of influence[17, 21], but the planning and execution of the project work is coordinated via program structures[27].

Pellegrinelli[29] points that sceptics have questioned the uniqueness features attributed to program management, arguing that it reflects a narrow conception of PM, disconnected from the lived experiences of competent practitioners. However, detailed research exists showing the similarities and differences between project and program management rooted in theoretical foundations. For example, Artto, Martinsuo, Gemünden, and Murtoaro[2] conclude that programs and projects have eleven distinctive characteristics. One key distinction is that compared to projects, programs' outcomes are broader, more indirect and more far-reaching with long-term implications in the future. Projects' outcomes are concrete business results, which contribute in a foreseeable manner to business success. Artto *et al*'s results largely confirm Lycett, Rassau and Danson[20] conclusions, stating that programs cannot and should not be treated as projects' scale-ups. However, the dominant perspective of program management is essentially project-based, tending to view program management as an extension of PM. Complexity and uncertainty are both attributes of programs[36]. Programs have complexity arising from interfaces between projects as well as combination and overlapping of project life-cycles[2]. Programs require a specific way of thinking - more tolerant of uncertainty, more embracing of change and more aware of wider business influences, since periods until completion are usually longer than for ordinary projects[28].

Unlike projects, programs do not necessarily have a single, clearly defined deliverable, or a finite time horizon[27]. These factors mean that a program may not have a pre-defined linear life-cycle comparable to a project life-cycle[30], which is not the case of the HMIExcel program that has a predefined life-cycle, namely because of the funding contract.

Understanding how to manage collaborative university-industry R&D funded contracts and their particular issues appear to be limited. However, there are some works that give guidance to the implementation and practice of general program management, namely the Standard for Program Management, from Project Management Institute, that describes the main generic phases of the program management life-cycle[17], the P2M a Guidebook for Project and Program Management for Enterprise Innovation issued by the Project Management Association of Japan[19], and the Managing Successful Programmes (MSP), published and used by the Office of Government Commerce in UK[11],

which is essentially a best practice framework which outlines how to best implement a long term program, through a set of principles and processes[30].

In general, program management standard approaches can be traced back into two erroneous assumptions: program management is in effect a scaled-up version of PM; and a single standard approach is applicable to all circumstances[20]. However, as Pellegrinelli[27] argues, different rationales for programs should lead to different program management configurations of program activities. Therefore, based on a review of the literature, a first conceptualization of the PPM approach drew largely on three main theoretical foundations:

- the Project Management Body of Knowledge (PMBoK) from the Project Management Institute (PMI)[16];
- the PM methodology for university-industry collaborative projects from Chin, Yap and Spowag[10]; and
- the Standard for Program Management, from PMI[17].

There has been an emergence of multiple bodies of knowledge (BoKs)/ standards, such as PMBoK, APM BOK[21], ICB3.0[9], and P2M[19]. The PMBoK from PMI, APM BOK from Association for Project Management and P2M from Project Management Association of Japan are of the most influential publications on what constitutes the knowledge base of the profession[25].

Although with different structures, the PM BoKs are all value-driven[34] and set out a broadly similar framework, requiring knowledge of techniques (such as project life-cycling, budgeting, scheduling, etc.) and management skills (such as control and co-ordination, leadership, etc.).

The PMBoK (fifth edition) was selected as a basis for the PPM approach proposed because is the simplest body of knowledge, with the primary focus upon task execution; however it fails to refer to the management of front-end issues, such as strategy or human factors[26]. The IPMA Competency Baseline (ICB) and APM BOK include the strategic, front-end management of projects. However, as argued by Morris *et al.*[24], the more tightly defined scope of the PMBoK might seem more accessible for practitioners than the wider range of the APM BOK or P2M.

The fifth edition of PMBoK divides the PM Knowledge into ten areas: integration; scope; time; cost; quality; human resources; communications; risk, stakeholders and procurement, which organizes 47 PM processes mapped also into five PM process groups: initiating; planning; execution; monitoring & control and closing. Each process is described in detail by their inputs, tools and techniques, and outputs.

PM methodology for university-industry collaborative projects from Chin *et al.*[10] was developed based on leveraging leading PM best practices and the examination of 19 structured interviews with university and industries (SMEs- small and medium size enterprises) partners. The basic structure of the methodology is divided into four modules outlined with thorough processes of initiating, planning, executing, controlling and closing of projects with selected toolkits and templates for implementation. For each module the key objectives, activities and outputs are outlined. The Chin Yap and Spowage's work was selected because it is one of the few studies particularly focused in the management of university-industry collaborative projects.

The third edition of the Standard for Program Management from PMI, highlights the full scope of program management work in five performance domains: program strategy alignment, program benefits management, program stakeholder engagement, program governance and program life-cycle management, while at the same time illustrates and clarifies the program management supporting processes that complete the delivery of programs in organizational settings. The Standard for Program Management was selected taking into account the similitude of objectives, robustness, and multitude of organizational contexts.

3. Research Methodology

The research methodology adopted to develop the new PPM approach followed Ahlemann[1] framework and the guidelines for conducting prescriptive PM research, which is concerned with the development of recommendations on how to solve a practical problem ("how"). Ahlemann[1] framework is based on a review of existing PM literature and thorough analysis of other successful prescriptive disciplines. The research methodology is divided in four phases: problem analysis; solution design; solution evaluation; documentation and communication.

In the first phase (problem analysis), the researchers iteratively analyzed the research problem of how to manage a complex collaborative university-industry R&D funded contracts. This analysis has considered both the particular characteristics of the HMIExcel program (that were collected by unstructured interviews) and the theoretical body of

knowledge (primarily, the Project Management Body of Knowledge (PMBoK)[16], the PM methodology for university-industry collaborative projects[10], and the Standard for Program Management[17]). The interviews were conducted with HMIExcel key stakeholders: the program manager, five of the thirteen project managers from UMinho, and three project manager officers, that supported administratively the management of the program. Each interview lasted between one and one hour and half. The main objective of the interviews was to understand the problem, identifying the needs of each stakeholder, since only this understanding will enable researchers, using also their expert judgment, to build a solution that addresses the underlying roots and causes.

In the second phase – solution design –, a variety of sources inspired the researchers, being the most significant the existing PM body of knowledge, referred above and discussed in the previous section. This research seeks to adapt and improve management approaches to a particular type of programs, rather than develop completely new ones. This phase resulted in a conceptual PPM approach in a collaborative university-industry R&D funding contract presented in detail in the following section.

In the third phase – solution evaluation – is being accomplished by assessing the effectiveness and efficiency of the proposed PPM approach in the HMIExcel program. This assessment will enable (1) to understand the conditions under which the PPM approach works, and (2) to identify the needs for improvements observing its use and collecting data on the outcomes. Therefore, the researchers adopted the following research methods:

- Observation. Monitoring regular management and technical meetings and assessing the quality of the documentation produced by the PPM approach.
- Questionnaire. Collecting data during one specific HMIExcel workshop, planned to March 2015, which will place together most of the stakeholders of the program (convenience sample).
- Focus group. Regarding some limitations of a questionnaire use, namely the rigid structure preventing the exploration of potential research findings, the conduction of three focus groups is planned, lasting 60 to 90 minutes, to get deeper insights, in order to enrich the data that was previously collected through the questionnaire and to contribute for their qualitative validation. Focus group has the advantage of easing the discussion and participation, since the answers of a participant can be complemented by another one, enriching the information. The selection of expert's participants will take into consideration their diversity, concerning the criteria: role, professional category, age, gender, and considerable experience in PM in practice and/or in PM research.

It is expected that the complementary strengths of a questionnaire instrument and focus groups will help the process of improving the PPM approach developed and the triangulation data analysis, contributing more effectively to a rigorous qualitative validation and reliability analysis[18].

Finally, in the fourth phase, the researchers will document and communicate their research results in such a way that professionals can easily apply them in practice. Therefore, a practitioner oriented publication is planned, namely a guidebook for the use of the PPM approach, to distribute by UMinho and Bosch_BrgP, as well as, scholarly publications, through articles in referred conferences and journals. The referred publications reinforce the PPM evaluation performed in phase three. The success of this study depends mainly on the research results adoption, and its documentation and communication is crucial.

This ongoing research study started in January 2014 and is planned to finish in December 2015. Mixed approaches tend to get lengthy, and almost impossible to report on a single readable paper. Therefore, this paper focuses on the presentation of the research first, second and the beginning of the third phases, which includes the main findings of the PPM approach implementation in the case study HMIExcel program based on the researchers' observation.

4. The Case Study HMIExcel Context

HMIExcel is a university-industry collaborative R&D funded contract. HMIExcel is the result of a partnership established between University of Minho and Bosch Car Multimedia Portugal in July 2012 for collaborative R&D, regarding the development and production of advanced car multimedia solutions. This section briefly contributes for the problem analysis phase, according to the research methodology.

Bosch Car Multimedia (Bosch_BrgP) located in Braga, Portugal, was founded in 1990. Over the years, Bosch_BrgP became one of the biggest suppliers for automotive industry and the leading plant of the Car Multimedia division unit of Bosch Group. Presently, Bosch_BrgP produces a wide portfolio of products, such as navigation systems,

instrumentation systems, car radios, steering angle sensors, and electronic controllers. In 2014, Bosch_BrgP achieved a turnover of around 433 million Euros, 99% for export, with around two thousand jobs.

University of Minho (UMinho) is currently among the most prestigious institutions of higher education in Portugal, and is in the top 100 universities under 50 years old (75th position) worldwide. Founded in 1973, UMinho is engaged in the valorization of the knowledge-research chain, development and innovation. UMinho stands out by the volume of publications and by the number of requested patents, as well as, by the high collaboration with industry, around 250 R&D contracts with industry are signed annually.

The HMIExcel program comprises fourteen multidisciplinary R&D projects combined into three application domains: product development, quality control, and production management (see Table 1). The main science and technology areas are: electronics and instrumentation, information technology, mechanical technologies and materials, industrial engineering and management, and human factors.

Table 1. Projects characterization.

R&D areas	Projects scope
Product development	Development of new concepts for polymeric screwless chassis; new coating techniques to enhance legibility levels of displays; new design methodologies to guarantee maximum reliability of PCBs; new human-machine interfaces based on innovations in design, ergonomics, perception and usability; and new automotive sensor systems.
Quality control	Development of systems to prevent PCBs warpage along the whole cycle; fast objective inspection systems for reliable quality check of displays; systems to evaluate quality and safety of new human-machine interfaces; quality control integrated system according to Quality Function Deployment; and Bosch Engineering Systems methods.
Production management	Development of integrated systems for planning, controlling, programming, monitoring and reporting of development, production; and quality control operations of new range of multimedia solutions.

The program began in May 2013, and will close in June 2015. The HMIExcel innovations will be incorporated into products expecting to generate international revenues of around one billion Euros between 2015 and 2018. The HMIExcel program foresees an investment of about €19 million, partly funded through the Portuguese incentives for research and technological development, involves around 300 researchers from UMinho and collaborators from Bosch_BrgP and entails the admission of 35 new staff totally dedicated to R&D in Bosch_BrgP and 59 new researchers for UMinho.

5. The Conceptualization of the PPM Approach

This section presents the solution design phase, according to the research methodology.

The management of a program of projects requires as a requisite the management of all the constituent projects. Therefore, the PPM approach proposed had a PM "layer" bellow the "layer" of the program management.

Establishing a common, and consistent set of management processes, defined phase by phase, can be very useful[17], although programs and projects vary significantly in scope, cost and complexity. Figure 1 shows the program management life-cycle divided into four phases:

- Program Preparation. Program preparation activities occur as the result of a formal or informal university-industry collaboration, in order to achieve a desired state within a portfolio of new R&D projects from both organizations. The main objectives are: to align a common strategy to the consortium entities, to identify the program scope, and to strive for the necessary resources to support new R&D projects, namely the financial support for the program. Typically, the 'Program Initiation' (next phase) of collaborative R&D programs is dependent on the available public financial incentives. Therefore, it is necessary to identify the suited financial system to submit the program, and progressively elaborate the program strategic objectives and outcomes, namely according the financial incentives system.
- Program Initiation. The main purpose is to guarantee the initial planning of the program and the alignment of the program objectives and outcomes with the stakeholders that will effectively get involved into program execution. Typically, collaborative R&D university-industry programs involve many university researchers and collaborators from the industrial organization, with distinct expectations, experiences and mindsets. Another important objective is the creation of a program support office (PMO) or its equivalent, namely to support the program governance.
- Program Benefits Delivery. Throughout this iterative phase, the projects of the program are planned, integrated and managed to facilitate the delivery of the intended program benefits.

- Program Closure. The objective of this phase is to execute a controlled closure of the program. This phase is also important to determine as to whether the collaboration can be sustained.

Figure 1 identifies the main inputs and outputs for each phase of the program life-cycle. Concurrently, during the entire program life-cycle, the program manager and the program team perform several tasks in order to assure[17]:

- Program Strategic Alignment. Identifying opportunities and benefits to achieve the both organization's strategic objectives through program implementation.
- Program Benefits Management. Defining, creating, maximizing, delivering and sustaining the benefits provided by the program.
- Program Stakeholders Engagement. Capturing and understanding stakeholder needs, desires, and expectations and analyzing the impact of the program on stakeholders, gaining and maintain stakeholders support, and managing stakeholder's communications.
- Program Governance. Establishing processes and procedures, for maintaining program management oversight and decision making support for applicable policies and practices throughout the course of the program.

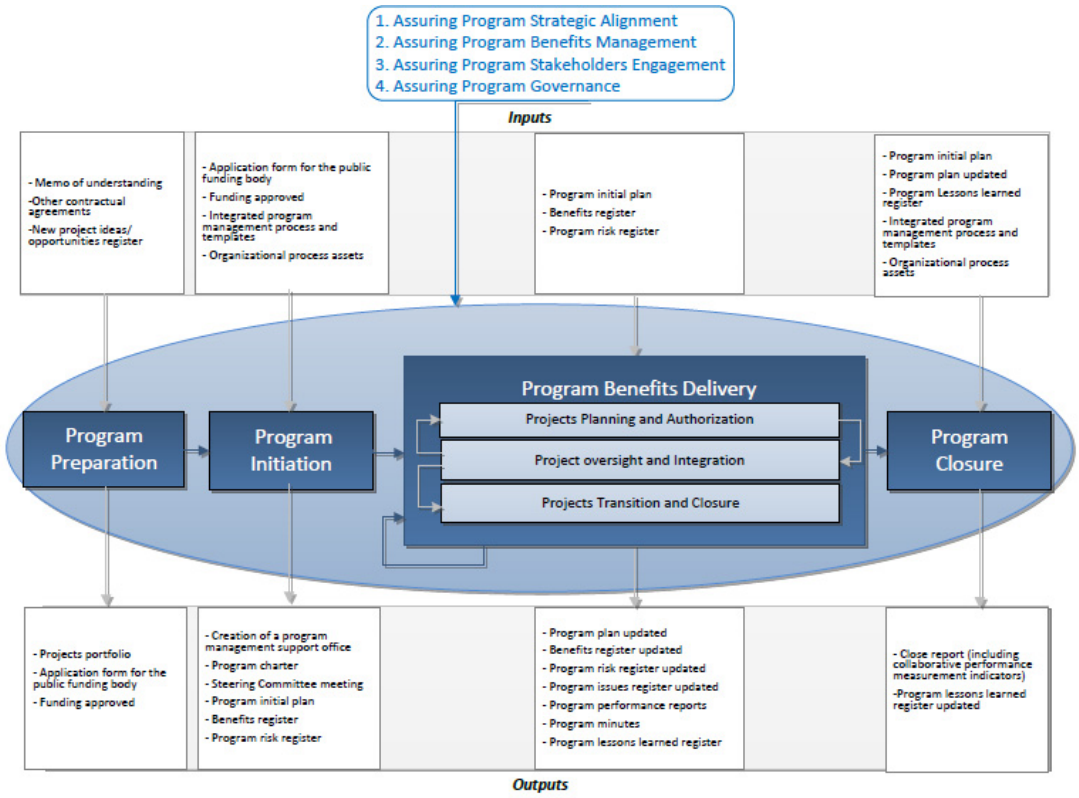

Fig. 1. Program management "layer".

The project management "layer" is not discussed in this paper due to the length restrictions.

6. Discussion

This section discusses the observations of the HMIExcel program considered to be the most relevant to highlight the key characteristics of the proposed PPM approach. It is important to note that the adoption of the PPM approach

within the HMIExcel program has skipped the 'Program Preparation' and the 'Program Definition' phases, since the HMIExcel program started before the PPM approach conceptualization.

The setup of the PMO (and supporting team) early in the program life-cycle is essential for the program success. Typically, both universities and industries do not have such supporting offices, so it makes even more critical the creation of a specific structure to manage and support such complex collaborative R&D funded contracts. In the case of the HMIExcel, the PMO team still perceives difficulties to perform its functions and responsibilities efficiently and effectively, because the PMO team has started to work after several months of the program initiation. When the PMO team started to work many key practices had not yet started to be performed. For example, (1) some project managers were not clear about the outcomes expected for their projects, because the program is approved by the two entities of the consortium, and has been initiated without asking the project leaders to review the plan made during the process of elaborating the funding request; (2) the definition of the roles and responsibilities of all the program management staff was still missing; and (3) a unique IT platform to support the communication between stakeholders was not deployed. These three examples clearly illustrate that the HMIExcel program would have benefited from the adoption of the recommendations that the PPM approach includes in the 'Program Preparation'.

When face-to-face progress meetings (between PMO team and project teams) started to be conducted on a regular basis (monthly), the collaboration between the university researchers and industry collaborators improved significantly. As suggested by Salas, Calder, Greitzer, and Lucas[32], these meetings have been supported by an overall communication routine to supplement the meetings (standardized monitoring reports). The observed positive effect of face-to-face progress meetings is thoroughly explained by Bozeman, Fay, and Slade[7]. The fourteen monthly 'project monitoring reports' are the main inputs to develop the monthly 'program performance report', which is perceived by the HMIExcel PMO team as the main practice implemented during the 'Program Benefits Delivery' phase.

The inclusion of one Bosch_BrgP and one UMinho representatives in every structure of the program organization was found extremely important for assuring collaborative decision-making and conflicts resolution.

The procurement process in both organizations has revealed to be one of the main difficulties in managing the HMIExcel program. The excess of bureaucracy is not suitable to such specific R&D funded contracts. In future programs, an appropriate procurement processes for both university and industry is recommended to be carefully studied and established during the 'Program Initiation'.

It is relevant to perceive that the funding nature of these collaborative R&D contracts limit the performance of the corresponding programs. Typically, several human resources are contracted for working specifically in the program, which means that when the program closes their work contract ends. There is a considerable difficulty to keep these human resources engaged during the whole program life-cycle and consequently it makes more demanding to manage the knowledge creation and exploitation processes[38]. It is frequent that the effective program starting date is not the same for the two entities of the consortium. The university is unable to start the work before signing the funded contract, whereas the financial autonomy of the industry allows complying with planned starting date. This temporal misalignment may carry serious implications to the program management.

7. Conclusions

This research builds knowledge in the domain of program and project management in collaborative university-industry R&D funded contracts, for which there is limited understanding.

As a result of the observation of the partial adoption of the proposed PPM approach in the HMIExcel program, emphasis should be given to structured objective setting, good progress monitoring and effective communication. The proposed PPM approach yields good results, since the HMIExcel program is delivering the planned results and benefits for both UMinho and Bosch_BrgP. The PPM approach is easily comprehensible and applicable. Nevertheless, the PPM approach is not a "recipe" to all collaborative university-industry R&D funded contracts. The program manager and the program management team should be responsible to adjust the PPM approach to better respond to particular program requirements.

Since this research study is still ongoing, further work is planned to evaluate the efficiency and effectiveness of the PPM approach. The application of a questionnaire and the conduction of focus groups will enable to improve the approach to accommodate, different stakeholders perspectives.

Universities and industries present completely different cultures and mindsets. Further research will be conducted to understand how to reduce this gap when both entities are involved in collaborative R&D initiatives, so that industries start to perceive universities as effective partners (and not as suppliers) and universities orient more their applied research to the actual needs/opportunities of their industrial partners.

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